1. From Narrow Band Telephony to HD Voice

VoIP-enabled Broadband Gateways are offered by Telco and Cable Operators throughout the world, as the popularity of double-play and triple-play service offerings is increasing. The current generation of VoIP-enabled Gateway devices typically have one or two FXS ports in order to connect a POTS-type telephone device. As service providers work to set themselves apart from competitors, wideband ("high definition") voice becomes an attractive differentiating feature. Standard wired and cordless telephones cannot support wideband audio, so a new solution is required - one not bound by the limitations of an FXS interface.

A solution for this is embedding cordless capability in the VoIP-enabled Gateway, using the evolved DECT cordless standard called CAT-iq, which is capable of delivering 7 kHz of audio bandwidth, while still offering backward compatibility with standard DECT handsets.

However, embedding cordless VoIP into the Gateway is a large commitment, in terms of design effort, BoM increase, certification costs, and time to market. An alternative is the use of an external USB Dongle containing DECT / CAT-iq functionality, giving the CPE supplier a low-risk, low-cost alternative to “upgrade” the Gateway with cordless functionality, while making only an investment in Host firmware.

This white paper will present such a USB Dongle, as well as explore some of the challenges normally associated with integration of communication hardware and software.

2. The End Users Perspective

A recent study conducted by IMS Research shows significant growth in the VoIP enabled Broadband Gateway / IAD and cable modem market driven by the popularity of double-play and triple-play service offerings.

The termination of the VoIP service has traditionally been through an FXS port so the end user could attach a corded or a cordless telephone.

However, as new VoIP services and 3G network integration emerge, wideband (7 kHz) or HD voice is getting more traction. The advantage for the end user is a superior voice quality compared to fixed-line telephony, but neither the existing FXS ports nor the legacy residential telephony equipment support HD voice.

The request from the end user is integrated telephony services from the line to the cordless handset (and freedom to choose from a wide range of handsets) - all at the lowest possible cost. This forces operators to rethink their product and service offerings.

RTX’s CAT-iq USB Dongle solution adds enhanced capabilities to the gateway, as it provides the end user with the possibility to conduct up to four simultaneous calls using gateway single Internet Access Device. In addition, the RTX CAT-iq USB Dongle allows the end user to have a shared Internet phonebook, which ensures phonebook availability regardless of the handset used and makes it simple for the end user to replace handsets without worrying about transferring phonebooks. Moreover, the RTX CAT-iq USB Dongle allows the end user to benefit from useful features such as call transfer, call logs (received, missed, placed), time and date synchronization, etc.

The RTX CAT-iq USB Dongle is a unique and flexible solution, which is tailored to bring value to the end user.
3. The Operators Perspective

When an operator provides HD voice services, customer retention can be improved through the superior user experience of HD voice. Operators need to differentiate their VoIP offerings but at the same time keep costs under control by leveraging their installed equipment base.

To differentiate services and reduce costs for new customers, operators can choose to deploy the RTX CAT-iq USB Dongle only to customers asking for cordless telephony. This allows the operator to lower CAPEX by offering a minimum number of gateways variants.

For existing customers, the RTX CAT-iq USB Dongle allows the operator to retrofit the installed base of gateways with cordless HD voice telephony services with a minimum of inconvenience for the end user. The installed base of gateways can easily be upgraded with a ready to plug-in RTX CAT-iq USB Dongle, and the up-front costs can be reduced.

Since the CAT-iq standard guarantees interoperability between handset manufacturers, operators can choose from a wide range of readily available CAT-iq handsets, all giving full access to new CAT-iq features.

4. The Gateway Manufacturers Perspective

Gateway manufacturers are sometimes reluctant to add additional wireless circuitry inside their products, as performance and certification challenges may greatly add to the product development cost. The RTX CAT-iq USB Dongle literally moves the DECT radio outside of the Gateway, which greatly reduces RF interference complications. Furthermore, an external radio can increase cordless range and reduce the product’s time-to-market compared to integrated solutions.

New telephony services utilizing CAT-iq 2.0 and the appropriate software on the Gateway, enable a whole new range of services that previously were impossible to deliver over the FXS port. Examples include Internet-based phonebook, shared phonebook with cellular phones, and remote provisioning of cordless equipment.

The RTX CAT-iq USB Dongle allows the Gateway manufacturer to extend the lifetime of its product portfolio, by providing a pre-certified, plug-in, low-risk solution to implement a CAT-iq compliant base station in the Gateway.

5. The Solution: An RTX CAT-iq USB Dongle

The RTX CAT-iq USB Dongle is a complete DECT / DECT 6.0 / CAT-iq 2.0 “Base Station” in the form of a USB dongle. It is fully compatible to a wide range of handsets and accessories, including headsets. It allows Gateway manufactures and operators to easily add cordless HD voice services to their installed portfolio of equipment, without the need for recertification or the risk of facing interference issues. The only requirements on the Gateway are a Host USB port, and the inclusion of firmware to bridge the Dongle to the VoIP application and audio stream.

The RTX CAT-iq USB Dongle is provided with a well-documented API as well as a Software Development Kit (SDK) to easily enable compatibility between the Dongle and the Gateway’s VoIP application.
5.1 Features

The following features are supported by the RTX CAT-iq USB Dongle:

- Full HD voice (7kHz audio bandwidth—double that of PSTN)
- LEDs for status indication; On / Off, ongoing call, no handset registered etc.
- Full Cordless Base Station functionality - supporting up to 5 cordless handsets
- Four audio lines on the USB interface - supports up to four simultaneous calls
- Firmware upgradeable from the Gateway host
- List access; Call log, missed calls, phonebook etc.
- Support for both CAT-iq 1.0, CAT-iq 2.0 and legacy DECT GAP handsets
- Full automatic speech CODEC management (Wideband / Narrowband)
- CODECs supported: Linear PCM, G.711A, G.711u, G.726, G.722
- License-based CODECs supported: G.722.2, G.729AB
- Optional button for paging of handsets and handset registration

The wide range of supported speech CODECs can in many cases offload the Operator’s network from performing trans-coding between CODEC formats, lowering the need for expensive DSP equipment in the Operator’s network.

6. Host Software Support

The RTX CAT-iq USB Dongle supports two Gateway integration options:
1. Directly using the USB Dongle API
2. Using the RTX SDK

The illustration below shows a simplified Gateway software architecture. The VoIP service is generally terminated in the TCP/IP stack as well as a SIP (Session Initiation Protocol) User Agent with suitable application on top. The voice path (not shown in the drawing) is handled by the Gateway DSP subsystem together with an appropriate RTP (Real-time Transport Protocol) stack.

6.1 Using the RTX CAT-iq USB Dongle API

The RTX CAT-iq USB Dongle exposes two bulk data endpoints; one for transmitting and one for receiving. When inserted into the Gateway, the Gateway USB driver enumerates these endpoints and thereby exposes a well-documented RTX CAT-iq Basestation API, as well as an encapsulation of voice frames.

The Gateway manufacturer or middle-ware developer can write the appropriate interworking units between the Gateway’s VoIP application and the USB driver.
6.1.1 Example Message Sequence Chart

The RTX API is fully documented and is used in many successful products. An example from the API documentation can be seen below.

---

6.2 Software Development Kit Simplifies Host Firmware Integration

To simplify the integration of RTX CAT-iq USB Dongle firmware into the Host, RTX offers a Software Development Kit (SDK). This SDK minimizes the effort needed on the Host side to support the RTX CAT-iq USB Dongle. The SDK contains a set of ready-to-use C API calls for controlling the RTX CAT-iq USB Dongle. Demo applications are included that will run under both Windows and Linux. The HTML-based documentation is comprehensive and intuitive to navigate, and Host source code is included with the SDK.

---

6.3 Roadmap for DECT and CAT-iq

Since 1993, DECT and related wireless technologies have been at the core of RTX’s design services and product business. RTX develops and maintains its own DECT and CAT-iq Protocol Stacks, which run on the baseband ICs of its DECT silicon partner, SiTel Semiconductor. RTX is committed to the long-term evolution of DECT and CAT-iq, and has introduced new capabilities such as eco-mode, ultra low power, over-the-air software updates, enhanced capacity, greater security, QoS, longer range, further enhancements to audio quality, audio streaming, etc.
7. Conclusions

The RTX CAT-iq USB Dongle is a new way of adding cordless voice to gateways. It provides a fast and low-cost solution to retrofit the installed portfolio of VoIP Gateways at customer premises, or to prolong the lifetime of existing Gateway designs.

The RTX CAT-iq USB Dongle is fully interoperable with existing DECT and CAT-iq handsets, which gives the operator full freedom to address different market segments through differentiation.

The RTX CAT-iq USB Dongle comes with a well-documented API for the advanced Gateway manufacturers wishing to take full control of the middle-ware; alternatively, RTX’s SDK can be used to implement the standard CAT-iq telephony features.

8. Glossary

<table>
<thead>
<tr>
<th>DECT</th>
<th>Digital Enhanced Cordless Telephony</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The worldwide standard for cordless telephony operating in a reserved frequency band</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SIP</th>
<th>Session Initiation Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The rapidly developing open source standard for VoIP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QoS</th>
<th>Quality of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mechanisms to differentiate traffic over IP or wireless interfaces, to e.g. ensure data traffic is not interfering with telephony services</td>
</tr>
</tbody>
</table>
## Technical Specifications

### DONGLE FEATURE

#### Cordless Standards Supported
- DECT (EN 300 175-1-8), DECT 6.0 (FCC part 15, Sub-part D, IC RSS-213),
- CAT-iq 1.0 (TS 102 527-1),
- CAT-iq 2.0 (TS 102 527-3), and future CAT-iq versions, as ratified

#### USB Audio Interface Options
- Two different options available:
  - Single Bulk Interface (Audio & Control; can directly pass G.722/726/711 audio streams)
  - USB audio device class and a HID control interface (exposed as composite device; automatically detected by Linux ALSA driver; uses 16-bit/16kHz linear PCM streams)

#### Feature Examples (accessed via API)
- Call Setup and Disconnect, Caller ID and Caller Name ID, parallel call services, call transfer, call logs (received, missed, placed), phonebook, CODEC negotiation, firmware update, time and date synchronization, etc.

### Over the Air CODECs Supported by Dongle
- G.722 (7kHz Wideband), G.726 & G.711 (both 3.4kHz Narrowband)

#### User Interface options
- Status LED, Page / Registration Button (optional via customization)

#### Wireless Security Protocol
- DECT Standard Cipher (DSC), using a 35-bit initialization vector and encryption of voice stream with 64-bit encryption

#### Simultaneous Phone Calls Possible
- 4 (wideband, narrowband, or combination)

#### Number of Antennas in Dongle
- 1 internal antenna (standard); polar diversity antennas (2) as custom option

#### Wireless Range
- Up to 50m indoors; up to 300m line of sight

#### Typical MIPS requirements from host CPU
- Approximately 5

#### Average Current Consumption (from USB)
- One Narrowband Call: 75mA; One Wideband Call: 90mA; Four (4) Wideband Calls: 135mA; Idle (Standby): 60mA; Suspend: <2.5mA

#### Dimensions
- 35mm x 70mm (Standard product)

Custom designs possible:
- Custom logo
- Custom colour
- Custom form factor and industrial design
The DECT Standards

DECT stands for “Digital Enhanced Cordless Telecommunications” and denotes a radio technology suited for voice data and networking applications. With long range capabilities up to several hundred meters, DECT operates in an unlicensed, protected frequency band. A broad selection of integrated DECT integrated circuits (ICs), RF parts, reference designs and complete DECT modules are available today. The DECT standard was developed and is maintained and advanced by the “European Telecommunication Standardization Institute” (ETSI) and is recommended by the “International Telecommunication Union” (ITU) for worldwide deployment. With its broad global industry support, DECT will remain the leading worldwide standard for secure, reliable, unlicensed and protected cordless communication.

CAT-iq stands for Cordless Advanced Technology, Internet and Quality, and is the global technology initiative from the DECT Forum and is designed for IP-voice services in the next generation networks. CAT-iq is based on the regulatory framework of the mature and reliable DECT technology. It is fully backward compatible to DECT GAP and, focuses on high quality wideband audio as well as low bit-rate data application. CAT-iq has been developed to meet the needs of the operators, in cooperation with the Home Gateway Initiative (HGI) and has been realized into technical specifications by the European Telecommunications Standards Institute (ETSI).